U. S. Dept. of Agriculture
W12,996

NASA PERIODIC REPORT

1 January to 30 June 1970

This report covers the period from January 1, 1970 to June 30, 1970. The major portions of this report are pattern recognition and soil mapping studies pertaining to soil classification. Other ancillary information includes progress reports from the photography laboratory, APT satellite tracking station, and mission records.

Pattern Recognition - General

Two major goals of the pattern recognition system are to develop an automatic pattern recognition system that is useful for analysis and feature development, feature selection, and classification of remote sensing data and to determine the usefulness of spot density readings made on Ektachrome infrared film for the classification of crops.

Pattern recognition programs presently being developed and tested are for use with the spot density measurements made with a Macbeth densitometer which has four filter combinations (Appendix A). Reports of these programs are printed in a line pattern plot and used to determine the sample distribution and probability density functions. Preliminary results show the K-class reports being 82% correct and the mode-seeking reports being 79.4% correct.

Corn was correctly recognized 55 times and wheat 64 times. Corn was recognized as wheat 15 times and wheat as corn 11 times. New programs under development include scatter diagrams with printer plot capability for shadings of different areas.

An adjunct study with the pattern recognition study is the solameter digitization and is essential to remote sensing aerial photography. Various models with absolute reference points will be tried with the data.

Pattern Recognition Programs

The following programs have been written and are given below in a brief summary.

Data Gaussian

Request a mean, standard deviation and number of observations and receive a gaussian (bell-shaped) distribution of generated data with characteristic n, 5, n.

Gamma Curve

For each data block supply a "header" card with maximum and minimum data values and the number of values per input record. Result -- Histogram plots of probability density and cumulative frequency for each data block.

Edit

Examines each mission -- run combination of digitized solameter data and decides (according to a specified parameter) whether re-evaluation is necessary on any one or more of the four solameter readings.

Data Pack

> Operates on densitometry data neutral filter, red filter, green filter, blue filter, and forms ratios (non-redundant) of neutral red, neutral green, neutral blue, red-green, red-blue and green-blue. Furthermore, computes means and standard deviations of these 10 elements over the number of members in a data set. The overall effect is to decrease the number of records but increase the data content of the records and thereby to some extent preserve the stat value of the original observation sets.

The following achievements have been recorded for this period:

Data Acquisition:

1. Pattern Recognition

   ≈ 4500 OBS @ 20/field of 17 classes @ 14,000' on August 7, 1969.

   ≈ 1250 OBS @ 5/field of 17 classes @ 60,000' on August 8, 1969 (NASA).

2. Solameter Digitizing

   98 runs of solameter data over 19 missions have been digitized @ 1/2" intervals and punched.

3. Multiple Inventory Coding

   Mission, film, strip chart inventories have been organized and updated for this year.

4. PRT Digitizing

   Preliminary training (methods, procedures, steps, necessary information, location of logs, etc.) has been carried out.

1969 P-R-D Survey:

1. Studies carried out or being carried out include:
   a. K-17 availability survey
   b. Experiment coverage survey
   c. "Experiment-wise" Date-Altitude-Run-Data Form survey on major experiments in 1969.

2. Preliminary steps have been taken toward tapping ASCS records for 1969 crop identification.

Preliminary Study Analysis:

Lower order moment analysis of unequal subclass case of high altitude pattern recognition data from NASA overflights have provided some preliminary data-structure conclusions as well as indications of some serious limitations to be dealt with in further studies. Graphical and tabular results point out desirable and undesirable aspects of the data and/or analysis procedures.

Storage/Retrieval Organization:

1. Graphs, tables and work sheets as well as pattern recognition notes are categorized and loose leaf bound. An "Operations" book has been created for three categories (a) Institute reference material procedures (b) Common computer error check lists and (c) day-by-day work lists -- to facilitate smoother operation within programming structure and pattern recognition efforts.

2. A card-data file has been created separate from a program-card file and each has been given a label-index system assignment.

Use of Photographic Data

Interpretation of color infrared and thermal infrared photography provided the basis for constructing a map delineating clay pan conditions. Clay pans are a major soil limitation and occur to some extent in all agricultural areas. Clay pans cause substantial reductions in crop yields.

The economic significance of this research finding is that the map can be used by those who wish to undertake remedial measures such as deep plowing, or it will serve to guide those who wish to plant crops more adapted to these conditions, such as shallow rooted grasses.

Much of the study area has been previously covered with a standard soil survey. As a part of this study, a graduate student has made extensive field investigations gathering soil moisture samples, gathered detailed soil data at specific sites and taken ground pictures. These field data are being correlated with aerial imagery in an attempt to improve the detailed surveys to provide a means of speeding up soil surveys.

The potential value of these studies lies in improving the accuracy of present surveys and in speeding up soil survey methods, the latter by permitting the soil surveyor to use remote sensing imagery to do a substantial amount of the delineation of soil boundaries in the office before going to the field.

The imagery taken in 1969 was examined noting the various soil patterns present. The soil patterns extend across several cropping situations. For this reason the identification of soil patterns is different for each cropping situation. The density differs for each crop which shows a soil pattern. Soil patterns observed were due to:

1. Claypan
2. Texture
3. Topography
4. Shallow depth to lime accumulation
5. Saline conditions
6. Rocks

Identification of these patterns requires procedures to recognize the texture of the patterns as well as the characteristic wavelengths involved. Base maps have been made along the Oahe soil line #1 for the soil patterns showing the various limitations to irrigation, as well as landforms. The limitations involved are:

1. Depth to claypan
2. Topography
3. Stoniness
4. Slowly permeable substratum
5. Wetness

The landforms found along this line are:

1. Undulating to rolling glacial till plain
2. Nearly level glacial lake plain
3. Nearly level to hummocky sands
4. Stream channels
    a. Flood plain
    b. Terraces

Because of the cropping patterns in the Oahe area only about 20-30% of the land surface is bare at any one time. For this reason the soil patterns are not identifiable at all times of the year or over all cropping situations. In August, 1969 the soil patterns appear best in fallow soil or green crops and not in stubble areas. For this reason the flights planned for 1970 are scheduled to best use the various crops grown in the area as indicators of soil limitations. The major crops are spring wheat, corn, oats, and hay. Two flights by the Remote Sensing Institute have been made during this period. One on May 26, 1970 and the other on June 25, 1970.

Other activities include improvising better forms for ground truth information as well as soil moisture data. Also Bureau of Reclamation maps were ordered for comparison with imagery.

Photographic Laboratory

Within the past month the photo lab at the Remote Sensing Institute has turned out well over two hundred prints which have aided research for such projects as insect infestation, river pollution, lake sedimentation, and water quality. These projects are being studied by Fred Schmer. The NASA project has utilized the photo laboratory heavily. Many prints of the Oahe soil lines were made for Bob Heil and Chuck Frazee, Plant Science Department. They used these prints to delineate clay pans and various soil types. Other studies for which prints were made include publications by Fred Waltz and also Black Hills rainfall and Rapid City interstate for Victor Myers.

An increasing need for black and white pictures was met with the help of Rod Ramsell.

As summer progresses many projects are shifting into high gear requiring a greater output from the photo lab. We are meeting that requirement with parttime help for the past few weeks.

Satellite Tracking Station

For several months the tracking station for ESSA and NIMBUS meteorological satellites at the Remote Sensing Institute has been inoperational because of various difficulties encountered with equipment.

The first receiver that was tried was too noisy and could not be quieted without a relatively large amount of test signal. Since it was known that the received signal would be quite small, a different receiver was tried. A converter was built, tested, and tuned to the right frequency.

No satellite was received until 50db of gain was attached at the antenna end. On June 18 the satellite picture was received at a frequency of 137.50 mega-hertz (ESSA 1). Other pictures have been received at frequencies of 136.95 (NIMBUS 3) and 137.62 (ESSA 8) mega-hertz.

At present, we are encountering difficulties in syncing the signal in at the right time, need a precision drive for the helix motor, need a reliable source for TBUS messages in order to locate the satellites and automatic turn on and off capabilities for the equipment.

Once we have the necessary starting information from the TBUS messages, a program is available that will enable us to tell the equator crossing time and thus tell us what time to start looking for the satellite.

Once the tracking station is fully operational the data on cloud cover will be used to plan flights on the various projects that the Remote Sensing Institute is involved in.

APPENDIX A

MACBETH DENSITOMETER TD-102

1. General Description

The TD-102 is a single-unit transmission densitometer equipped with four selectable filters for color and visual density measurements within a range of 0-4.0 density units. Separate mechanical trimming controls enable precise individual zeroing of each of the selectable filters contained in the instrument. The readings taken with the TD-102 indicate American Standard diffuse transmission density.

2. Optical System

Optical Geometry: Meets ASA standard PH2.19-1959 for measuring diffuse transmission density.

Color Filters:

Turret Position	Filter Wratten
Red	92
Green	93
Blue	94
Visual (neutral)	106

3. Operation

The TD-102 is always turned on so no warm up time is involved. Positive transparencies are placed on the instrument so that readings may be taken at specific points. These points are ascertained by location of panel markers in the transparency. A reading for each turret position or filter is taken without raising the snout.

APPENDIX B

INSTITUTE VISITORS

Date	Name	Address
1/15	Merlyn Veren	Washington, D. C.
1/27	Paul Wheeldon	Ag. Eng. Depart., SDSU
1/28	Group tour	Huron College
2/2	Eldon Ortman	Insect Lab, SDSU
2/10	R. L. Vernard	S.D. Livestock Feeders Vermillion, S. D.
2/11	Don Von Steen	ARS, Washington, D. C.
2/19	Jim Sass	KESD TV, SDSU
2/24	Ray Fary Harry Rotis	USGS, Washington, D. C. USGS, Washington, D. C.
2/25	A. Forrest Troyer	Mankato, Minnesota
3/19	John Wiersma	Water Resources Institute SDSU
3/24	Merlin Tipton	Assoc. State Geologist Vermillion, S.D.
3/25	Bob Heil Fred Westin	Plant Science, SDSU Plant Science, SDSU
3/31	Clyde Brashier	Univ. of South Dakota Vermillion, S. D.
4/1	Paul Schleusener	In. of Atmospheric Sciences Rapid City, S. D.
4/2	Frank Shideler	Editorial Off., SDSU
4/16	Maury Horton	Plant Science, SDSU
4/22	Tour	Committee D - State officials Pierre, South Dakota

APPENDIX B (cont.)

Date	Name	Address
4/27	Mr. Gardner	Animal Science Dept., SDSU Rapid City, S. D.
4/28	Dr. Herb Gurk & Assoc.	RCA, New Jersey
5/5	Duncan McGregor	State Geologist Vermillion, S. D.
5/13	A. Blair Rains	Land Resources Swbiton Surey, England
5/14	Tour	Agricultural Engineering Staff - SDSU
5/14	Tex Lewis	Animal Science Dept, SDSU
5/21	Dr. Parikh	Bacteriology Dept., SDSU
5/26	Robt. Lindvall	USGS, Denver, Colorado
5/27	Alan Parker	Daedalus Enterprises Ann Arbor, Michigan
6/1	Dr. Gurloff	Insect Lab, SDSU
6/3	Bill Wilson	Bendix, Ann Arbor, Mich.
6/4	Tour	South Dakota 4-H Clubs
6/10	Mr. Anderson	USGS, Minnesota
6/22	Merlyn Veren Ben Nelson	Washington, D. C. State Weed Control Super. Pierre, South Dakota

APPENDIX C

SPEECHES GIVEN BY RSI STAFF

Date	Speaker	Organization
1/20	Myers	South Dakota Fertilizer Assoc. Sioux Falls, S. D.
2/4	Myers	IEEE, SDSU
2/9	Myers	Conservation District Supervisors Annual Banquet Desmet, S. D.
2/16	Waltz	Horticulture Dept., SDSU
3/17	Myers	Pollution Seminar, SDSU
3/18	Myers	Lower James Conservancy Sub-District, Mitchell, SD
3/30	Schmer	Crop and Livestock Improvement Assoc., Miller, S.D.
4/1	Schmer	Kiwanis Club, Flandreau, SD
4/2	Waltz	Bankers Association Pierre, S. D.
4/13	Myers	Geoscience Symposium Washington, D. C.
4/15	Waltz	Dutch Elm Committee Sioux Falls, S. D.
4/22	Waltz	Dutch Elm Committee Sioux Falls, S. D.
4/30	Waltz	Rotary Club Watertown, S. D.
5/4	Myers	Graduate Student Seminar Ag. Eng. Dept., SDSU
5/7	Myers	Businessmen's Banquet Howard, S. D.

APPENDIX C (cont.)

Date	Speaker	Organization
5/11-13	Myers	Seminar guest speaker Stanford University, Calif.
5/13	Waltz	Electrical Engineering Seminar SDSU
5/18	Waltz	Data Handling Seminar, SDSU
5/18	Waltz	Lions Club Brookings, S. D.
6/4	Lemke, Waltz	State 4-H Club tours and presentations.

APPENDIX D

REMOTE SENSING INSTITUTE
South Dakota State University

Mission Flight Information

Mission No: 104 Date: May 26, 1970

Site: Oahe and Oahe Reservoir

Run No:	6	7		
Line No:	3	4		
Heading:	270°	90°		
Altitude, AGL:	14,500	14,500		
Clouds:	H-Cirrus	H-Cirrus		
Haze:	Heavy	Mod. Heavy		
Start Time:	1456:20			
End Time:	1506:00			
Hass Cameras (Frame No):	21-34	35-47		
No. 1(70mm) Film No:	144	-SAME-		
Film Type:	8403			
Filter:	58			
No. 2(70mm) Film No:	145			
Film Type:	8403			
Filter	25A			
No. 3(70mm) Film No:	146			
Film Type:	8443			
Filter:	30M G15			
No. 4(70mm) Film No:	147			
Film Type:	2448			
Filter:	HF3+4			
K-17 Cameras (Frame No):	1-17	18-34		
No. 5(6-in) Film No:				
Film Type:				
Filter:				
No. 6(12in) Film No:	157			
Film Type:	8443			
Filter:	G1.5 30M			
PRT Chart No:				
Scanner Chart No:				
Solameter Chart No:	9058			
Mark 1-G, Filter	-	-SAME-		
1250, Filter	58			
1251, Filter	25A			
1252, Filter	89B			

Comments:

APPENDIX D
REMOTE SENSING INSTITUTE
South Dakota State University

Mission Flight Information

Mission No: 112 Date: June 25, 1970

Site: Oahe Soil Lines

Run No:		4	5		
Line No:		3	4		
Heading:		270°	90°		
Altitude, AGL:		14,500	14,500		
Clouds:		Clear - 10% Cumulus			
Haze:		Very Heavy ---			
Start Time:		1248:34	1306:41		
End Time:		1255:55	1311:29		
Hass Cameras (Frame No):		27-36	37-47		
No. 1(70mm)	Film No:	191			
	Film Type:	8403			
	Filter:	55			
No. 2(70mm)	Film No:	192			
	Film Type:	8403			
	Filter	25A			
No. 3(70mm)	Film No:	193			
	Film Type:	8443	-SAME-		
	Filter:	G15 30M			
No. 4(70mm)	Film No:	194			
	Film Type:	2424			
	Filter:	89B			
K-17 Cameras (Frame No):					
No. 5(6-in)	Film No:				
	Film Type:				
	Filter:				
No. 6(12in)	Film No:				
	Film Type:				
	Filter:				
PRT Chart No:					
Scanner Chart No:					
Solameter Chart No:		9064			
Mark 1-G, Filter		-			
1250, Filter		58			
1251, Filter		25A	-SAME-		
1252, Filter		89B			

Comments: